

“Half Bridge” Low $V_{CE(on)}$ IGBT INT-A-PAK, 200 A


INT-A-PAK IGBT

FEATURES

- Trench IGBT technology
- Gen 4 FRED Pt® technology anti-parallel diodes with ultra soft reverse recovery characteristics
- Very low conduction losses
- Al_2O_3 DBC
- UL approved file E78996 
- Designed for industrial level
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


RoHS
COMPLIANT

BENEFITS

- Optimized for high current inverter stages (AC TIG welding machines)
- Direct mounting to heatsink
- Very low junction to case thermal resistance
- Low EMI

PRIMARY CHARACTERISTICS

V_{CES}	650 V
I_C DC, $T_C = 80\text{ }^{\circ}\text{C}$	378 A
$V_{CE(on)}$ at 200 A, $25\text{ }^{\circ}\text{C}$	1.09 V
Chip level $V_{CE(on)}$ at 200 A, $25\text{ }^{\circ}\text{C}$	0.98 V
Speed	DC to 1 kHz
Package	INT-A-PAK
Circuit configuration	Half bridge

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Collector to emitter voltage	V_{CES}		650	V
Continuous collector current	I_C	$T_C = 25\text{ }^{\circ}\text{C}$	476	A
		$T_C = 80\text{ }^{\circ}\text{C}$	378	
Pulsed collector current	I_{CM}	$T_C = 175\text{ }^{\circ}\text{C}$, $t_p = 6\text{ ms}$, $V_{GE} = 15\text{ V}$	810	
Diode continuous forward current	I_F	$T_C = 25\text{ }^{\circ}\text{C}$	57	
		$T_C = 80\text{ }^{\circ}\text{C}$	43	
Maximum non-repetitive peak current	I_{FSM}	10 ms sine or 6 ms rectangular pulse	270	
Peak switching current	I_{LM}		320	
Gate to emitter voltage	V_{GE}		± 20	V
RMS isolation voltage	V_{ISOL}	Any terminal to case, $t = 1\text{ min}$	2500	
Maximum power dissipation	P_D	$T_C = 25\text{ }^{\circ}\text{C}$	1000	W
		$T_C = 80\text{ }^{\circ}\text{C}$	633	
Maximum power dissipation (Diode)	P_D	$T_C = 25\text{ }^{\circ}\text{C}$	150	
		$T_C = 80\text{ }^{\circ}\text{C}$	95	
Operating junction temperature range	T_J		-40 to +175	$^{\circ}\text{C}$
Storage temperature range	T_{Stg}		-40 to +150	

**ELECTRICAL SPECIFICATIONS** ($T_J = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Collector to emitter breakdown voltage	$V_{BR(CEs)}$	$V_{GE} = 0\text{ V}$, $I_C = 800\text{ }\mu\text{A}$	650	-	-	
Collector to emitter voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}$, $I_C = 200\text{ A}$	-	1.09	1.32	V
		$V_{GE} = 15\text{ V}$, $I_C = 400\text{ A}$	-	1.32	-	
		$V_{GE} = 15\text{ V}$, $I_C = 200\text{ A}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	1.07	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$, $I_C = 4.0\text{ mA}$	4.0	4.8	6.0	
Temperature coefficient of threshold voltage	$\Delta V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}$, $I_C = 4.0\text{ mA}$, ($25\text{ }^{\circ}\text{C}$ to $125\text{ }^{\circ}\text{C}$)	-	-14.8	-	mV/ $^{\circ}\text{C}$
Forward transconductance	g_{fe}	$V_{CE} = 20\text{ V}$, $I_C = 100\text{ A}$	-	455	-	S
Transfer characteristics	V_{GE}	$V_{CE} = 20\text{ V}$, $I_C = 200\text{ A}$	-	6.65	-	V
Collector to emitter leakage current	I_{CES}	$V_{GE} = 0\text{ V}$, $V_{CE} = 650\text{ V}$	-	0.5	200	μA
		$V_{GE} = 0\text{ V}$, $V_{CE} = 650\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	0.17	-	mA
Diode forward voltage drop	V_{FM}	$I_C = 50\text{ A}$, $V_{GE} = 0\text{ V}$	-	2.0	2.9	V
		$I_C = 50\text{ A}$, $V_{GE} = 0\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	1.6	-	
Gate to emitter leakage current	I_{GES}	$V_{GE} = \pm 20\text{ V}$	-	-	± 480	nA

SWITCHING CHARACTERISTICS ($T_J = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Total gate charge	Q_g	$I_C = 200\text{ A}$, $V_{CC} = 520\text{ V}$ $V_{GE} = 15\text{ V}$	-	1763	-	nC
Gate to emitter charge	Q_{ge}		-	301	-	
Gate to collector charge	Q_{gc}		-	509	-	
Turn-on switching energy	E_{on}	$I_C = 200\text{ A}$, $V_{CC} = 325\text{ V}$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$ $R_g = 4.7\text{ }\Omega$, $T_J = 25\text{ }^{\circ}\text{C}$	-	1.1	-	mJ
Turn-off switching energy	E_{off}		-	9.7	-	
Total switching energy	E_{ts}		-	10.8	-	
Turn-on delay time	$t_{d(on)}$		-	60	-	ns
Rise time	t_r		-	60	-	
Turn-off delay time	$t_{d(off)}$		-	520	-	
Fall time	t_f	$I_C = 200\text{ A}$, $V_{CC} = 325\text{ V}$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$ $R_g = 4.7\text{ }\Omega$, $T_J = 125\text{ }^{\circ}\text{C}$	-	57	-	mJ
Turn-on switching energy	E_{on}		-	1.1	-	
Turn-off switching energy	E_{off}		-	13.7	-	
Total switching energy	E_{ts}		-	14.8	-	
Turn-on delay time	$t_{d(on)}$		-	60	-	ns
Rise time	t_r		-	61	-	
Turn-off delay time	$t_{d(off)}$		-	580	-	
Fall time	t_f		-	137	-	
Reverse bias safe operating area	RBSOA	$T_J = 175\text{ }^{\circ}\text{C}$, $I_C = 320\text{ A}$, $V_{CC} = 325\text{ V}$, $V_p = 650\text{ V}$, $R_g = 4.7\text{ }\Omega$, $V_{GE} = 15\text{ V}$ to 0 V , $L = 500\text{ }\mu\text{H}$	Fullsquare			
Diode reverse recovery time	t_{rr}	$I_F = 50\text{ A}$, $dI_F/dt = 500\text{ A}/\mu\text{s}$, $V_{rr} = 200\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	79	-	ns
Diode peak reverse current	I_{rr}		-	10.5	-	A
Diode recovery charge	Q_{rr}		-	409	-	nC
Diode reverse recovery time	t_{rr}	$I_F = 50\text{ A}$, $dI_F/dt = 500\text{ A}/\mu\text{s}$, $V_{rr} = 200\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	141	-	ns
Diode peak reverse current	I_{rr}		-	19	-	A
Diode recovery charge	Q_{rr}		-	1336	-	nC

THERMAL AND MECHANICAL SPECIFICATIONS

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS
Operating junction temperature range	T_J	-40	-	175	$^{\circ}\text{C}$
Storage temperature range	T_{Stg}	-40	-	150	
Junction to case	R_{thJC}	-	-	0.15	$^{\circ}\text{C}/\text{W}$
		-	-	1.0	
Case to sink per module	R_{thCS}	-	0.1	-	
Mounting torque	case to heatsink	-	-	4	Nm
	case to terminal 1, 2, 3	-	-	3	
Weight		-	185	-	g

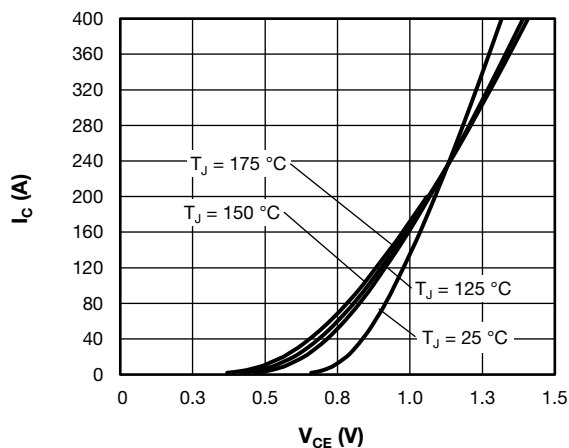
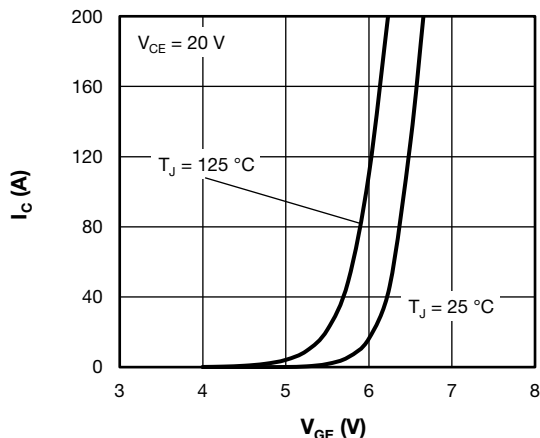

Fig. 1 - Typical Trench IGBT Output Characteristics, $V_{GE} = 15\text{ V}$


Fig. 4 - Typical Trench IGBT Transfer Characteristics

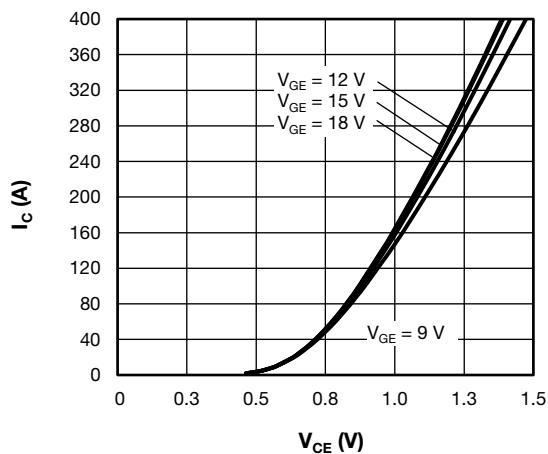
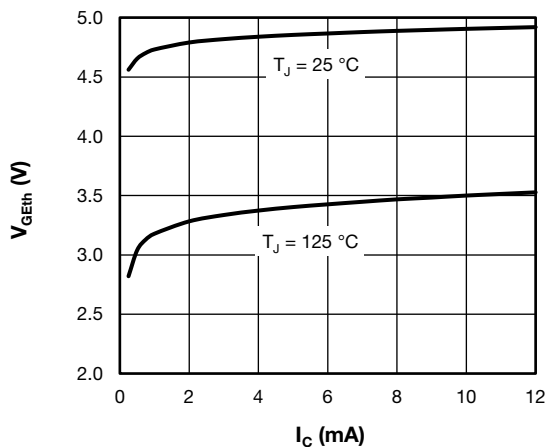

Fig. 2 - Typical Trench IGBT Output Characteristics, $T_J = 125\text{ °C}$


Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

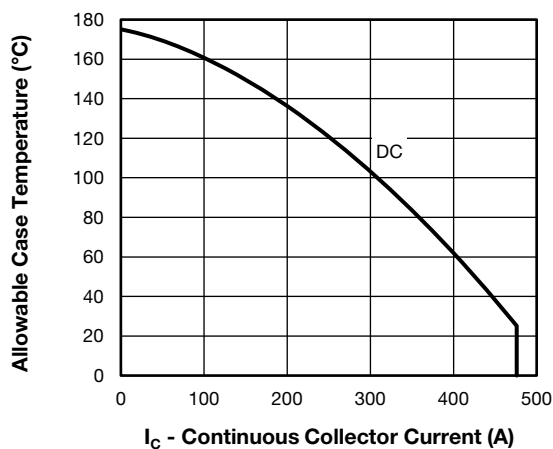


Fig. 3 - Maximum Trench IGBT Continuous Collector Current vs. Case Temperature

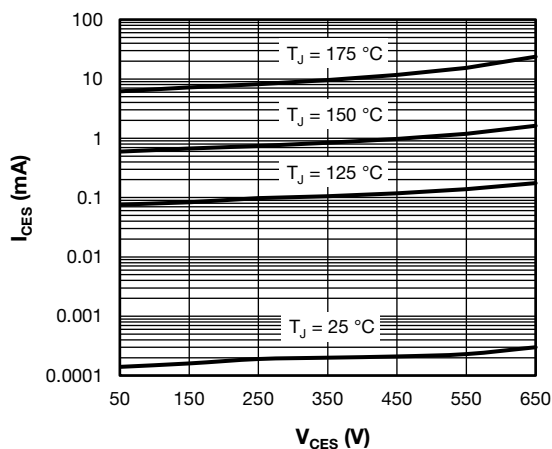


Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

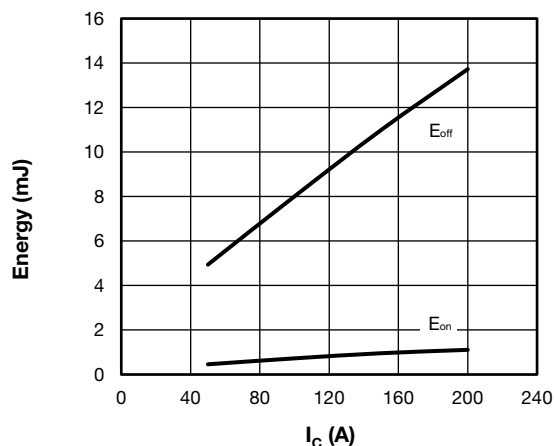


Fig. 7 - Typical Trench IGBT Energy Loss vs. I_C
(with Antiparallel Diode)

$T_J = 125^\circ\text{C}$, $V_{CC} = 325\text{ V}$, $R_g = 4.7\ \Omega$, $V_{GE} = +15\text{ V} / -15\text{ V}$, $L = 500\ \mu\text{H}$

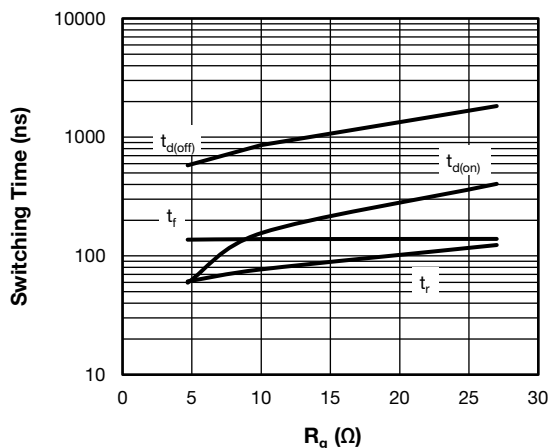


Fig. 10 - Typical Trench IGBT Switching Time vs. R_g
(with Antiparallel Diode)

$T_J = 125^\circ\text{C}$, $V_{CC} = 325\text{ V}$, $I_C = 200\text{ A}$, $V_{GE} = +15\text{ V} / -15\text{ V}$, $L = 500\ \mu\text{H}$

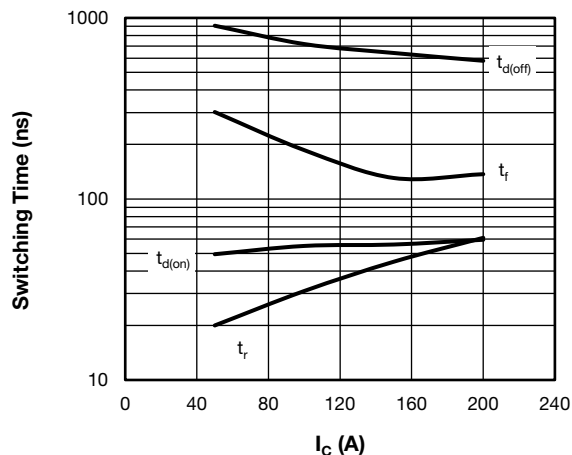


Fig. 8 - Typical Trench IGBT Switching Time vs. I_C
(with Antiparallel Diode)

$T_J = 125^\circ\text{C}$, $V_{CC} = 325\text{ V}$, $R_g = 4.7\ \Omega$, $V_{GE} = +15\text{ V} / -15\text{ V}$, $L = 500\ \mu\text{H}$

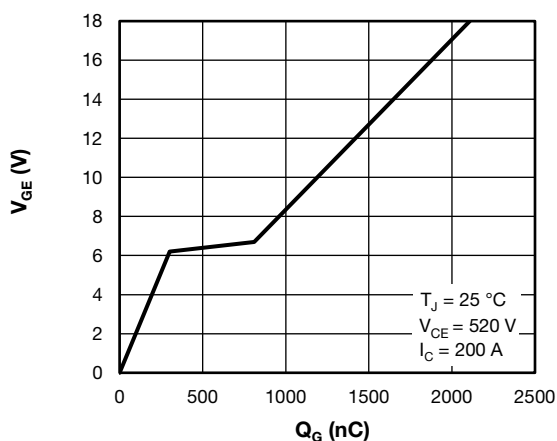


Fig. 11 - Typical Trench IGBT Gate Charge vs.
Gate to Collector Voltage

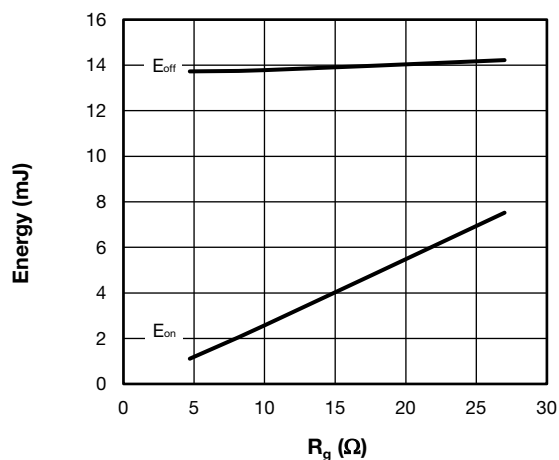


Fig. 9 - Typical Trench IGBT Energy Loss vs. R_g
(with Antiparallel Diode)

$T_J = 125^\circ\text{C}$, $V_{CC} = 325\text{ V}$, $I_C = 200\text{ A}$, $V_{GE} = +15\text{ V} / -15\text{ V}$, $L = 500\ \mu\text{H}$

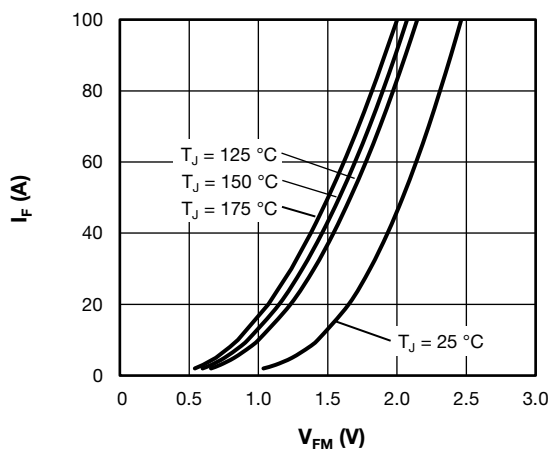


Fig. 12 - Typical Antiparallel Diode Forward Characteristics

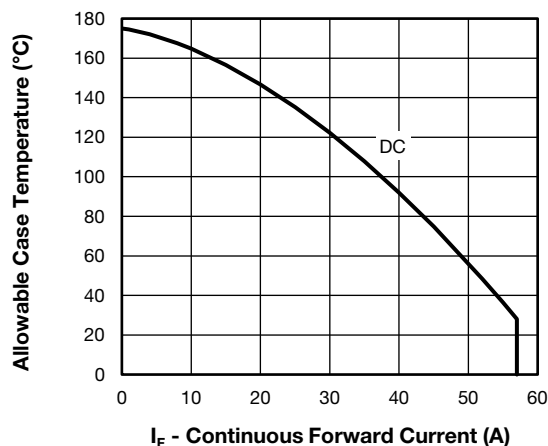


Fig. 13 - Maximum Antiparallel Diode Continuous Forward Current vs. Case Temperature

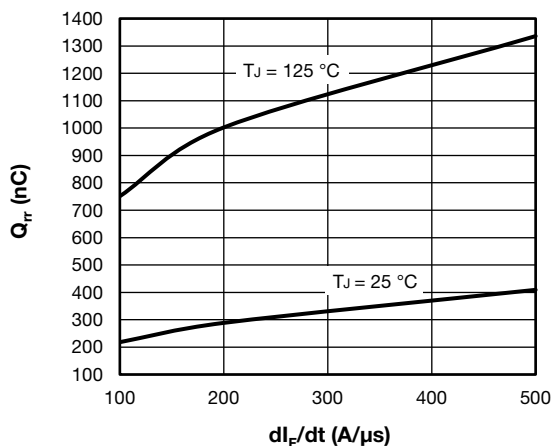


Fig. 16 - Typical Antiparallel Diode Reverse Recovery Charge vs. dI_F/dt
 $I_F = 50\text{ A}$, $V_{CC} = 200\text{ V}$

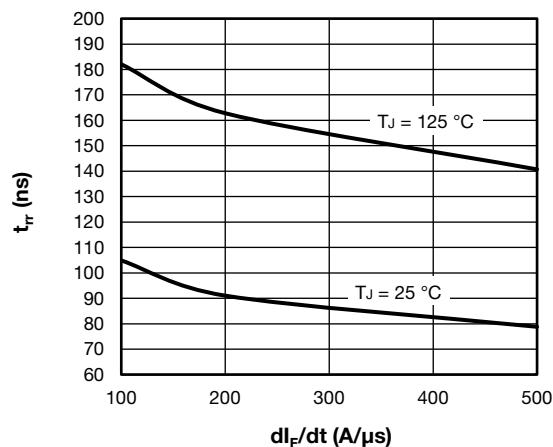


Fig. 14 - Typical Antiparallel Diode Reverse Recovery Time vs. dI_F/dt
 $I_F = 50\text{ A}$, $V_{CC} = 200\text{ V}$

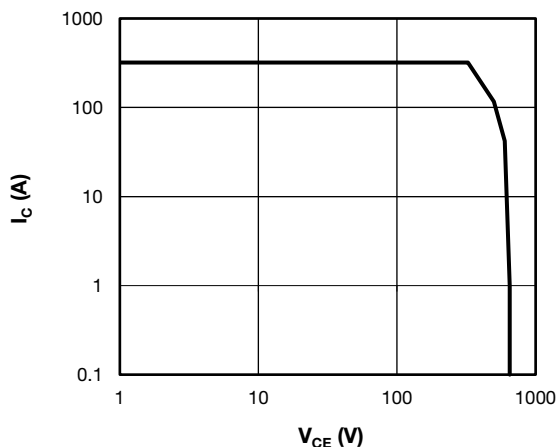


Fig. 17 - Trench IGBT Reverse BIAS SOA
 $T_J = 175^\circ\text{C}$, $I_C = 320\text{ A}$, $R_g = 4.7\ \Omega$, $V_{GE} = +15\text{ V} / 0\text{ V}$, $V_{CC} = 325\text{ V}$, $V_p = 650\text{ V}$

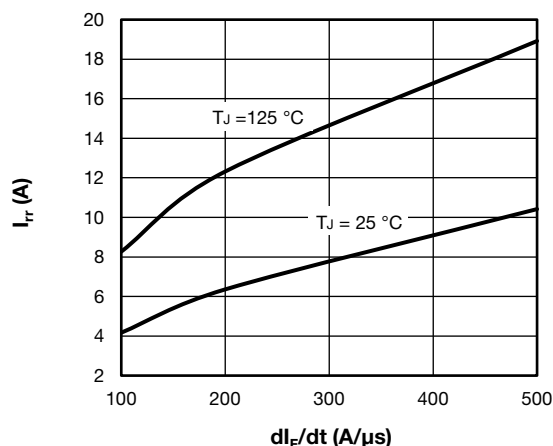


Fig. 15 - Typical Antiparallel Diode Reverse Recovery Current vs. dI_F/dt
 $I_F = 50\text{ A}$, $V_{CC} = 200\text{ V}$

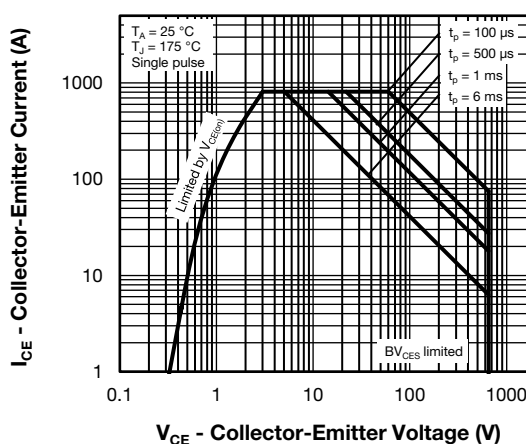


Fig. 18 - Trench IGBT Safe Operating Area

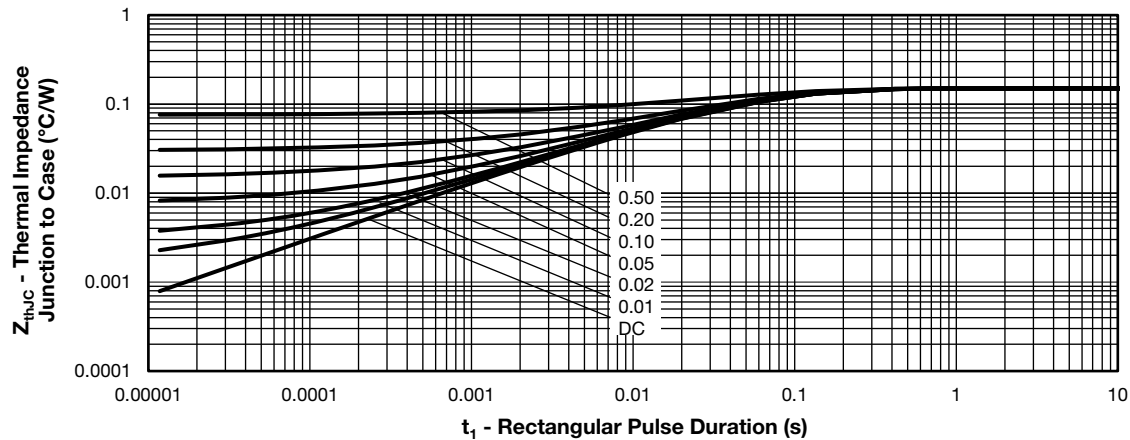


Fig. 19 - Maximum Trench IGBT Thermal Impedance Z_{thJC} Characteristics

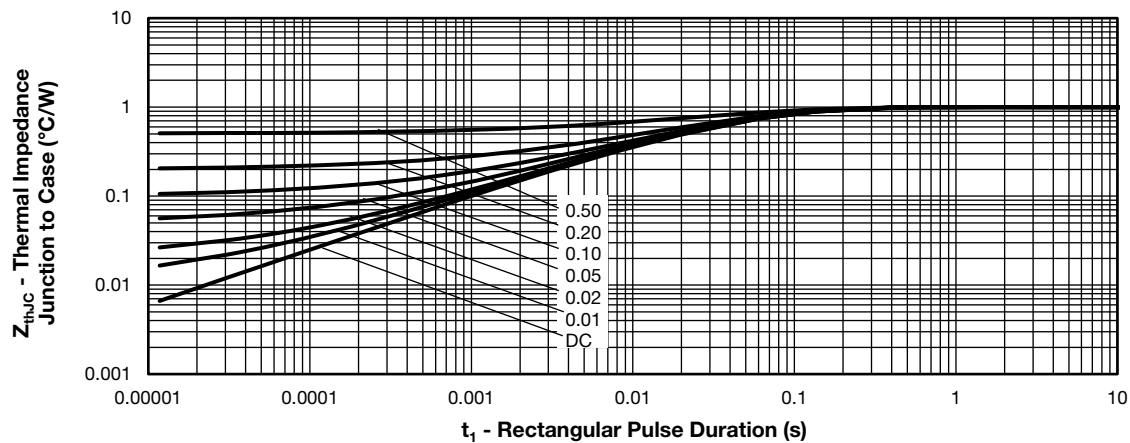
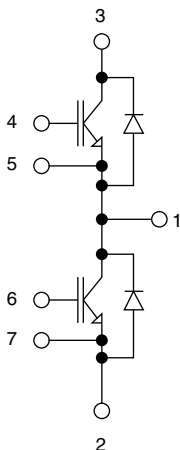


Fig. 20 - Maximum Antiparallel Diode Thermal Impedance Z_{thJC} Characteristics

ORDERING INFORMATION TABLE

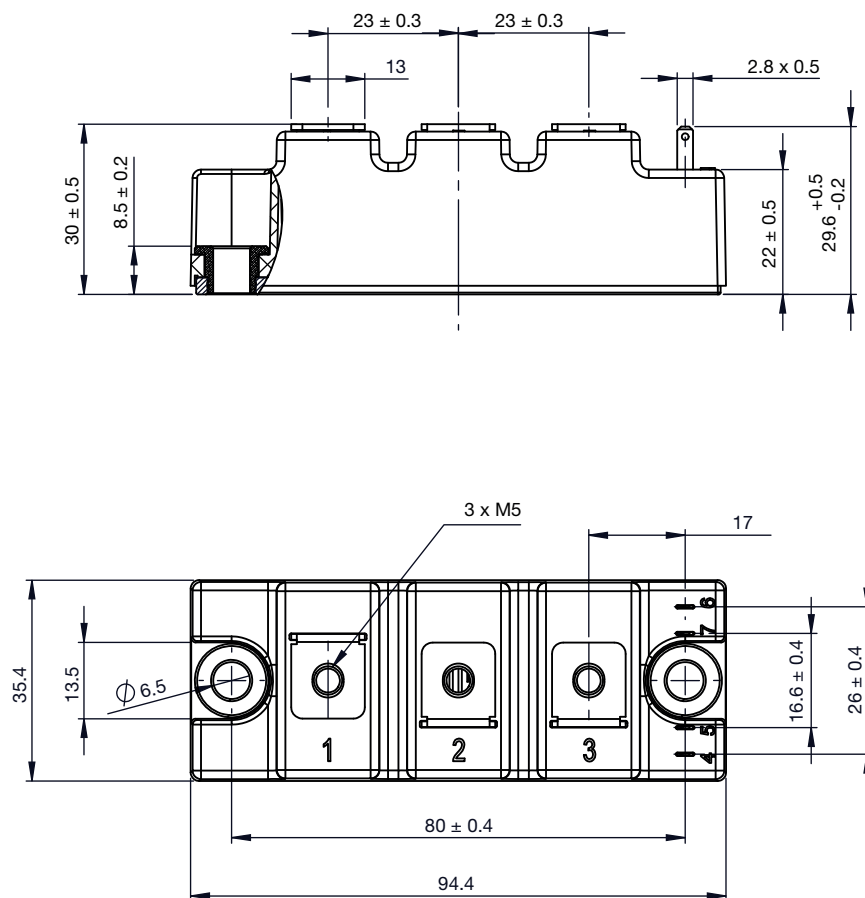
Device code	VS-	G	T	200	T	S	065	S
	①	②	③	④	⑤	⑥	⑦	⑧

- | | | |
|---|---|--|
| 1 | - | Vishay Semiconductors product |
| 2 | - | Insulated Gate Bipolar Transistor (IGBT) |
| 3 | - | T = trench IGBT |
| 4 | - | Current rating (200 = 200 A) |
| 5 | - | Circuit configuration (T = half bridge) |
| 6 | - | Package indicator (S = INT-A-PAK IGBT) |
| 7 | - | Voltage rating (065 = 650 V) |
| 8 | - | Speed type = (S = standard speed IGBT) |

CIRCUIT CONFIGURATION




DIMENSIONS in millimeters (inches)



General tolerance ± 0.5 mm



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